

Transactions *of* The Chartered Surveyors' Institution

SESSION 1938-1939.

AT THE ORDINARY GENERAL MEETING

*Held at the Chartered Surveyors' Institution, Monday,
6th March, 1939.*

Sir CHARLES BRESSEY, C.B. (President), in the Chair.

NEW MEMBERS.

The following new members were received by the
PRESIDENT prior to the meeting and signed the Register:—

Professional Associates :

APPLETON, GEOFFREY MAURICE
DAVEY, JOHN HECTOR
HOWARD, RAYMOND

RYDE, E. F. M.
WATKINS, N. D.
WILSHIRE, A. S.

A DISCUSSION took place on Sir ERNEST DOWSON and Mr. V. L. O. SHEPPARD's paper entitled

THE DEVELOPMENT AND FUNCTIONS OF
CADASTRAL OPERATIONS.

The CHAIRMAN said he believed the subject of the paper was rather unfamiliar to London surveyors and should therefore possess more interest for them than those subjects which came in their daily round. It was generally only those surveyors who practised abroad who were versed in the subject of cadastral operations. He imagined that Sir Ernest Dowson and Mr. Sheppard had had wider opportunities than any other members of the British race for learning to the full every phase and every aspect of the subject. Both of them had gained their experience initially in Egypt, where cadastral operations, he believed, had reached a very considerable pitch of perfection ; at any rate, great importance was attached to the matter in that country. Subsequently the authors had extended their experience by study of the work in other countries and visits to many of them.

As could be seen from the tables given at the end of the paper, the authors had been able to summarise the progress made in the work over wide areas of the civilised globe. It was one of the privileges of the Institution to gather into its fold surveyors practising in every part of the dominions overseas. There was now a Survey Centre at the Institution, of which Mr. McCaw was in charge, and it would, he believed, play an ever-increasing part in the work of the Institution and add more to its prestige.

Colonel H. C. COLE, C.B.E. (Vice-President), in proposing a vote of thanks to Sir Ernest Dowson and Mr. Sheppard for their paper, said the word " cadastral " had a rather sinister sound, especially to English ears. He did not know the reason for that—whether it was the resemblance of the word to "*cadavre*," or whether it was that English people thought the result of perfect *cadastre* would be an interference with their rights and privileges in regard to such property as they might still possess, or whether it was that they thought cadastral operations would lead to the employment of more officials. However, he was sure that no member present that evening would have to inquire, as most English surveyors had had to inquire up to date, what a *cadastre* was,

because they had been told exactly what it was and how it was operated in many different countries.

His first introduction to the extraordinarily interesting subject of cadastral operations was after the War, when he had been engaged on compensation for properties which had been requisitioned abroad and for what was called *remise en état* and compensation in respect thereof. In doing this work he had found that, when all boundaries had been destroyed and when the land had nothing like its original character, the presence of a *cadastre*, even though incomplete, was extraordinarily valuable.

In the paper the history of the *cadastre* had been touched upon, but he was informed that it was far more ancient than was stated in the paper. He had it on the authority of a great surveyor friend of his in France, René Danger, that in Chaldean times, 2,500 years before Christ, there had existed stone records very similar to a *cadastre*, and that those records, which had now been deciphered, carried on them the names of the owners of properties, descriptions of the properties, even the rents and profits, and in some cases something approaching a list of servitudes. There was no doubt that the Chinese had had *cadastres* and probably the Aztecs in South America had had them, and he believed that in ancient Egypt something of the same kind had existed.

The Institution was obviously much more interested to-day in the subject of cadastral operations than it had been heretofore. It had started a Survey Centre, as the President had said, and had been fortunate enough to secure as members of its new Land Survey Committee a number of eminent surveyors, some of whom were present that evening and some of whom were outside the ranks of the Chartered Surveyors' Institution. Mr. Sheppard had given a great deal of help in connection with the International Federation by taking a great interest in the Cadastral Committee of that Federation. He had been a source of joy to the foreigners, who had been able to pick his brains and get records from him which they would not have obtained so readily in any other manner. Sir Ernest Dowson had also given great assistance on the Land Survey Committee, but, he believed, had not been able to continue his membership, owing to pressure of other matters. When the International Federation held its first meeting in 1878, so important was the subject of *cadastres* considered that it was one of the first matters discussed in Brussels, especially from the point of view of the type of *cadastre* to adopt and the uses to which that type, if adopted, could be put. Since then those interested in the subject had travelled a long way, but to English surveyors the *cadastre* and cadastral operations immediately suggested registration.

The authors touched on the subject of registration in their paper and then, he thought very wisely, avoided discussing that subject in detail. He did not know whether there were any lawyers present that evening, but, as all surveyors were aware, the question of registration opened up such a large field of discussion *vis à vis* the conveyancers that it was just as well for a humble surveyor to keep silent on the matter. He wished, however, to remind the members that, apart from Domesday Book and possibly tithe maps and tithe records, very little was done in this country in the matter of registration until very recent times, and even now he thought he was right in saying that registration was compulsory only in the administrative counties of London and Middlesex and in the county boroughs of Croydon, Eastbourne and Hastings, although it was to become compulsory in Surrey next year. There was registration of deeds in Yorkshire, but, of course, such registration did not avoid detailed investigation of title for a conveyance.

There was no mention in the paper, he thought, of the Scottish system of registration. In Edinburgh, at the Register House, there were kept the Register of Sasines, and on this register, divided into counties, were marked all transaction in property including servitudes, charges, transfers of property on conveyance and on death, &c. One of the preliminaries, and an essential one in a Scottish conveyance, is a search in the appropriate register, either a property search or a search for incumbrances or both, according to the nature of the conveyance or transaction. These "searches," carried out by professional searchers in Edinburgh, formed part of the title-deeds.

In those parts of England where registration was not compulsory it was being used to a greater extent every day, especially in the areas which had recently been developed (in which areas he was afraid the Ordnance Survey had had great difficulty in keeping up to date) and in those areas where changes in proprietorship were constantly taking place.

He wished to express his admiration of the conveyancing lawyers. When surveyors dealt with the purchase or sale of property, if they were wise they made their negotiations and their bargains subject to contract, and it was at that point, after the surveyor had finished his work, that the troubles of the solicitor commenced. In a non-compulsory registration area, before the solicitor could give the purchaser the title he desired, he had to contend with many delays, he had to make many inquiries and searches and he had to avoid all the manifest pitfalls in connection with the incidence of tenure. When one thought also of the financial risk probably attaching to the solicitor, who, in spite of

all his care, might not produce a good title, and when one remembered that the profession of the law, in spite of all that, had been able to carry on without registration, he thought it would be agreed that the profession was to be admired. In many cases when a property was described by that profession it was described in words. The surveyor always said "Show me a plan," but not so the lawyer; the lawyer said "Show me the adjoining owners and the boundaries, and I will describe the property."

He intended to leave the technical discussion of the paper to others, but he wished to stress the point that, if surveyors were to help in the work, lawyers should come to them for plans and should talk about property in reference to plans and not in reference to a number of words or adjoining owners.

He supposed that the ideal would be to have a perfect *cadastre* in this country. There should be full registration and there should be, either in each county or in some other local centre, plans and full records of all the properties in the county, with the mortgages and all other charges marked, but he did not think that even he himself would have the temerity to say that record should be made public. If, however, a portion of it was public or could be readily inspected, he thought it would have a tremendous national value, quite apart from the commercial value that it might have in connection with the transfer of property. When one was dealing with the acquisition of property for any public purpose or if one had in the future to consider damage by air raids and so on, surely it would be of inestimable value for the country to have at its disposal a full record of ownership of all properties, with plans attached.

He was glad to see it stated in the paper that there could be no general universal form of *cadastre*; a *cadastre* was a living thing and it must follow the national life, in the same way as the laws of a country followed that life. It would, of course, be of great value to have a general form of *cadastre*, so that, no matter what language it was written in, the formula could be understood in every country and the salient features picked out, but that, he was afraid, was as impossible of achievement as a national language. He might say, in passing, that he had noticed that on the so-called German records shown on the screen that evening all the words were in French, but he thought the country in question must have been Alsace or Lorraine.

He begged to move that a most hearty vote of thanks be accorded to Sir Ernest Dowson and Mr. Sheppard for the trouble and care which they had taken in the preparation of their paper and for attending the meeting that evening in order to expound it to the members of the Institution.

Mr. G. T. McCaw, C.M.G., O.B.E. (Chartered Surveyor), said it gave him great pleasure to second the vote of thanks to Sir Ernest Dowson and Mr. Sheppard.

He had had the privilege of having had something to do in the past in a humble capacity with previous papers by the authors, and he could say, looking back on some of those papers, that he seemed to see in the paper which had been presented that evening a triumph of accomplishment. He thought the authors had produced something of a logical nature, something of a highly developed kind, which would, he was sure, form the basis of any textbook which might be written on the subject in the future.

There were a few points in the paper to which he would like to refer. He was pleased to see that the authors had found a new etymology of the word *cadastre*. He himself had been aware only of the old one, and, being interested in derivations, he had taken the trouble to look up some of the words mentioned by the authors. It appeared that the word *stichon*, to which reference was made in the paper, was really derived from an older word, *stix*, but that had nothing to do with the murky river *Styx* of the nether world. It was used in Attic Greek in connection, perhaps, particularly with what was known as *stichomuthia*, which meant the recital of single lines by the members of the caste in a Greek drama. He could find no reference to the use in Byzantine Greek of the word *katastikhon*. However, he looked it up in two dictionaries of modern Greek, and although he could not find that word, he found in both a regular word for a cadastral register. Both dictionaries agreed in calling it *ktematologion*, which simply meant a register of property. Littré and the Oxford Dictionary both agreed on the word *capitastrum*, the Roman pole-tax, as the origin of the word *cadastre*.

The authors referred in their paper to the origin of certain *cadastres*, and mentioned Wurtemberg in 1818. He suggested that they had omitted one which came very shortly after 1818, *i.e.*, Ireland, 1825. As far as he could see, that cadastral survey of Ireland was fully entitled to be considered as on the same lines as the old *cadastres*. He did not mean, of course, that there was a registration of title, but the work was undertaken in order to implement the Poor Law Act of 1824. Men of broad views in the Irish Government at that time saw that a survey was necessary, and pressed that so strongly on the Government of the country that they succeeded in bringing the whole of the Ordnance Survey across to Ireland. He thought that the date 1825 was rather interesting from that point of view, because it marked the real beginning of the civil duties of the Ordnance Survey in this country.

In the year 1825 the surveys were confined to the townlands,

a word which he noticed that the authors had used that evening, but the townland in Ireland was rather different. It was associated with a hamlet or hamlets and represented a small area; it was the smallest divisional unit in the country. The Ordnance Survey in Ireland began with the townland boundaries, since the poor rate was first assessed on the valuation of the townlands. As could be imagined, when the townland was surveyed and valued it was difficult to fix the taxes to be paid by the individual holders in the townland, so that in 1852 there was passed the Tenement Valuation Act of Ireland, under which it became necessary to have an official valuation of every hereditament in the country. That, of course, threw more work on the Ordnance Survey, but they stepped wonderfully into the breach. Although perhaps only the demarcation of the boundaries of holdings was required, they set themselves in Ireland to survey every visible feature, so that every field could be valued; that was really the beginning of the system which had been carried out thoroughly in this country. It was officially kept up to date by an annual revision, so that it was never allowed to fall into desuetude and become inoperative. He thought, therefore, that one was entitled to consider that as a proper cadastral survey—still in existence and still maintained in all parts of Ireland. It had been used for all sorts of purposes of recent years.

He agreed with the authors in doubting the truth of the saying that a map was a good servant but a bad master. He thought a good map was a good servant and a good master, but it must be read in the sense which was intended. It was not intended to show whether a certain side of a wall was a boundary between properties: it was intended only to show visible features. The marking of the boundaries was left to the cadastral survey or afterwards.

There were not many points which anyone could call in question; the paper indeed was the work of the highest authorities on the subject in the British Empire. He thought that the definition of registration of title given by the authors was one which could be very easily grasped and was very valuable, because it seemed to express the whole thing in a nutshell. Registration of title was the integration of registry of deeds.

The authors spoke about the marking of the boundaries as preventing any possibility of confusion with regard to numbering. He could endorse that, because he had been engaged in the work himself for a time in Ireland; the townlands corresponded to the blocks mentioned and the numbering was limited by their boundaries. The Ordnance 6-inch sheets which were used were quite ample for the purpose, and there was no

possibility of confusion between the numbers of the townlands. The system of numbering was not quite the same as that which the authors described, but it was very similar.

With regard to the existence of maps on a scale of 1/2500, he had seen the statement to which the authors referred put rather differently; he did not recall it in the Report which they mentioned, but it used to be stated that there was no part of the world in which a published and purchasable map of the whole of the cultivated part of the country existed on a scale larger than 1/2500 except Britain. From what the authors had said it would seem that Egypt should be excluded, but he thought the statement applied generally. In France the scale was 1/2000; the maps were nevertheless very useful, although very much out of date, but they were not published and could be obtained only at the *mairie*. With regard to Germany, he had not been able to examine the facts fully, but the idea that he used to have was that in Bavaria the *Flurkarten* were on the scale of 1/5000 and that the larger scale was not universal in Germany. Furthermore, it was a fact, he believed, that the "cadastrals" of Alsace-Lorraine were not published.

The paper was full of matters of interest, about which one could talk for a long time. At the end of it a list was given of those countries which had adopted systems of registration of title, and to that list one more name could now be added, because last year the Straits Settlements (which were not quite the same as the Federated Malay States, although the government was very much the same) had adopted registration of title.

He wished to say how pleased he was to have the honour of congratulating the authors on their paper and seconding very cordially the vote of thanks which had been proposed.

Brigadier M. N. MACLEOD, D.S.O., M.C. (Director-General, Ordnance Survey Department, Southampton) said he agreed with Mr. McCaw that there was a great deal in the paper which one would like to discuss, but he would confine himself to a few points only.

In the first place he would like to make it clear that the existing 1/2500 Ordnance map, though it was commonly called a cadastral map, was, in point of fact, not a cadastral map but a topographical map. A cadastral map was concerned with property boundaries, and the Ordnance Survey did not show property boundaries as such, but only topographical features. It could be used for cadastral purposes, because it happened that there were in this country so many topographical features that nearly every property was bounded by a topographical feature such as a fence

or ditch ; and, when that was not so, the boundary could be defined in words with reference to some topographical feature—that it was 2 feet from a hedge, for instance.

In the paper there was a very good description of what a cadastral survey was and what it had to do. He thought it might be said that one of the functions, perhaps the principal function, of a cadastral survey was to enable the exact position of a boundary or a boundary mark to be verified, and, if necessary, re-established, to the satisfaction of all parties concerned. He had had several conversations with Sir John Stewart-Wallace, the Chief Land Registrar, on the uses of surveying, particularly in connection with the use of the Ordnance Survey map by the Land Registry, and Sir John had astonished him one day by saying that he did not consider real accuracy in a map was essential for Land Registry purposes. He had replied: "Surely it must be so. How can you re-establish the position of a boundary mark if it has been moved if you cannot rely absolutely on your survey?" Sir John replied in effect: "That has nothing to do with the Land Registry. It depends on the way the law is framed. If you, as a property-owner who has registered a property in the Land Registry, say that a boundary mark has been moved it is up to you to prove it. The Land Registry does not undertake to prove that. It only registers such and such a property as being yours, and, if you do not consider the property, as you buy it from Tom, Dick or Harry, to be the same as it was when it was registered by him, the Courts of the country are open to you to prove your case." Whether one could prove it without an accurate survey was quite another matter, and as he was not a lawyer, he did not know whether there was another way ; he had not been able to think of one. So far as the Land Registry was concerned they contended that the function of the map was to enable the purchaser or the Land Registry, or anyone else concerned, to identify with certainty which particular parcel was concerned. In this country an air photograph or an inaccurate map could be used for that purpose, because the country was very thickly populated and a man would have to be very clever to be able to move a boundary mark without his neighbour discovering it.

With regard to the question of the numbering of parcels, which was bound up with the question of publishing the maps, as the authors and Mr. McCaw had said, it was not the custom in the greater part of the world to publish the cadastral survey. If anyone wanted to look at the map he had to go to the town hall or to the headquarters of the Land Registry and pay a fee, and if he wanted the map copied he had to pay for that. That

was obviously a much less convenient procedure than going to the nearest Ordnance Survey agent, paying 6s. 8d., and going away with the map, and it seemed to him that if the country went to the expense of carrying out an accurate survey it was worth going to the little extra expense of publishing it. Though that complicated the question of revision very much. If it was published, the problem of keeping it up to date became more difficult.

In conclusion he would like to refer to the collection of cadastral maps and records which Sir Ernest Dowson and Mr. Sheppard had been so generous as to present to the Government in 1934. That collection was now housed at the Ordnance Survey Department in Cromwell Road, and he was glad to say that Sir Ernest Dowson and Mr. Sheppard were still keeping the maps and records up to date. He strongly recommended anyone who was interested in the subject to go there and inspect the collection.

Colonel P. K. BOULOIS, O.B.E., M.C. (Geographical Section, General Staff, the War Office), said it might interest the members to hear a little more about *cadastres* from one who had had certain rather novel dealings with them.

His first experience was the most interesting because it was an unusual one. It was in connection with the settling of an international boundary—that between Germany and Poland—immediately after the War. The international boundary there was usually defined as following the boundary of a certain province or "*kreis*," and that was a very difficult thing to establish when boundary stones could not be located. All the province boundaries along the German-Polish international boundary, however, were accurately re-established by reference to the German *Grundbuch*, which was mentioned in the paper. He wished to bear testimony to the accuracy and the up-to-dateness of the *Grundbuch*, which could be seen at the mayor's headquarters in every *Gemeinde*; it contained the whole record of every property and of its conveyance and all information about it. It had been necessary to go into great detail to find the province boundaries and to re-establish the lost boundary marks and also to go into the petty economics of the boundary. It was extraordinarily interesting to see how satisfied people would become on a boundary which looked almost incapable of rectification if one could go into the little daily details of their economic situation—a village cut off from its well, a brick factory in which the wet clay was cut off from the dry clay, and so on. For all those purposes reference was needed to the *cadastre* of the local *Gemeinde*. That had been his first experience of the value of the *cadastre*.

Secondly, he had been a long time on the Ordnance Survey in charge of the division which had to do with the revision of the 1/2500 map. At that time there were only very few men indeed available to do the work. He had been impressed then by the extraordinary value of the 1/2500 map for all cadastral and property purposes. A point that had been borne in on him was the difficulty inherent in the old traditional habit of numbering every parcel. In the old days there were parish numbers, and then, as the parcels were divided up, so the original number had to be divided up, so that there came to be, for instance, on a plan parcels numbered 25*a*, 25*b*, 25*c*, 35*d*, and on many plans that went to 25*z* and started again at 25*aa*. It was beginning to become a hopeless situation in many parishes. As the members probably knew, the Interdepartmental Committee, under the chairmanship of Lord Davidson, which had recently reported, had recommended that parcel numbers should be abolished altogether. He knew that that had caused a little fear in the minds of some of the members of the Institution, but he assured them that it was not a thing to be deprecated at all. They would be able to refer to any parcel in a future Ordnance Survey map by the co-ordinate reference of the number, which gave the acreage of that parcel, and that, in his opinion, would be a far more satisfactory method than perpetuating the system of parcel numbers, which might go from *a* to *z* and then to *aa*, and so on.

That brought him to his last point, which was the value of the grid in cadastral matters, which was a subject to which Sir Ernest Dowson and Mr. Sheppard had not referred. In looking at the very interesting slides which had been shown that evening it had passed through his mind how valuable a rectangular grid would be in all cadastral operations. It would be very much more convenient to have a short grid reference instead of the textual definitions which he had noticed on the slides. Six figures would possibly avoid sixty words, and the grid reference was perfectly exact and could be understood by everybody. He had also been impressed by the number of times that it had been necessary to write the addresses of people. An address in England was sometimes fairly long, but one in Egypt was even worse. He visualised the day in the no doubt very distant future when intelligent people would gradually use the national grid to the point where it replaced the present system of addresses. Instead of putting the number of the house and the name of the road, the town or village and the county, it would be much better to put "123456," which would give the house a definite location on the earth's surface.

He would like to conclude by saying how interested he had been in the paper.

The vote of thanks was accorded with acclamation.

Sir ERNEST DOWSON, in reply, thanked the members on behalf of both the authors for the extremely generous reception which they had given to the paper. He touched briefly on a few points raised in the discussion ; but it was agreed, on the Chairman's motion, that a fuller reply should be submitted by the authors in writing.

The following is the written reply by Sir ERNEST DOWSON and Mr. SHEPPARD regarding certain points raised in the discussion on their paper :—

We should like in the first place to call attention again to two conditions which governed our paper and which were, we think, overlooked, perhaps to some extent usefully, in the discussion that followed. The first of these conditions was the necessity to postpone consideration of the technical aspects of cadastral operations to a later paper, the second the extreme difficulty which we experienced to condense even the remaining half of our subject into an afternoon's paper. These conditions precluded our paper from dealing with many of the points raised in discussion, while the exigencies of space must, we are afraid, continue to do so here. But the unavoidable inadequacy of our reply must not be taken as a failure to appreciate points that cannot be commented on.

Colonel Cole touched on the pre-history of cadastral operations. This is an interesting subject and certainly merits a more comprehensive and scientific study than it has yet received ; but this would demand a paper to itself. He also ascribed to prudence in avoiding a thorny subject the limitations imposed by the needs of condensation on our consideration of registration of title.

We have doubtless at times tended to avoid the term " register " of title to land " and to prefer the European term " land book " (*livre foncier, grundbuch*), or even " land register," simply because these terms suggest a less limited scope. Moreover, the subject matter of our paper, cadastral operations, is even more comprehensive still. But we have surely not omitted to give as full measure of consideration to the processes of registration of title as a reasonable measure of balance within our wider subject permitted. We are also moved to protest against the assumption that land surveyors should keep silence when the mysteries of registration of title are mooted. It is indeed a main burden of our paper that such silence is professionally culpable and has been a major cause of the quite unnecessary delays and difficulties that have been encountered in England in establishing this essentially simple

and common-sense record since its introduction was first attempted some eighty years ago. We think that we should also add that we have now been personally associated with the introduction of registration of title into a number of countries and that we have always found the legal profession, when sensibly approached, most ready to accord full consideration to technical and administrative requirements, although they naturally wish to be reasonably satisfied thereon and regard some matters from different standpoints. It is, of course, also necessary for the land surveyor who is concerned with cadastral operations of any sort to take the trouble to understand the main legal requirements of the work.

We regret that by an oversight we omitted an explanatory note to our appendix to say that it was not exhaustive. We omitted Scotland from the list of countries having systems of registries of deeds because this list was expressly limited to associations of such systems with fiscal cadastral surveys; but we gladly recognise the high reputation enjoyed by the Scottish Registry of Sassines and also by the Yorkshire Registry of Deeds. In a shorter paper presented by us to the Sixth Congress of the International Federation of Surveyors in Rome last summer we drew attention to the great confidence enjoyed by both. In addressing a British audience this seemed unnecessary.

We are interested in the claim advanced by Mr. McCaw that Ireland should be included among the countries in the first category in our appendix. We hope to have an opportunity to discuss this suggestion with him properly later. He also asked us to explain our statement that an effective register of title must adapt itself to changes in social habits. The sentence to which he refers runs:—

“ An effective register of title to land must also be designed to give satisfactory service unceasingly from the time of its inception onwards, adapting itself to changes in land tenure, in social habits and in working procedure as these arise, without any further need for corporeal reconstruction.” (*Transactions*, p. 172.)

Our essential point in brief was that a register of title once initiated should be sufficiently elastic to respond without organic reconstruction to future changes of any character that it was likely to encounter. Among such we instanced changes in land tenure: but this term is commonly taken to mean statutory tenure, which may omit important effects arising simply from the habits and conventions of the particular society concerned with regard to the occupation, use and/or ownership of land. As an illustration may be cited the custom of periodically redistributing village lands, which is widely (but not, of course, exclusively) prevalent in Palestine and known locally there as *mesha'*. This varied from

village to village in the period, basis and methods of such distribution, but was quite unknown to the law. These variations are too lengthy to detail, as are also the needs of these village societies to which under pre-War Ottoman administration these processes responded, or were thought to respond. But if a land register is to be a reliable record of the situation of the land, it must provide for the faithful record of effects of this nature when they occur and are duly recognised by the administration and the courts of the country concerned, as also for their modification or abandonment should these follow. Other examples could be readily cited.

We have endeavoured to answer this question more explicitly than has been possible in other cases, both because it is apposite and because we were expressly asked to do so ; but the fact that it has taken over two hundred words to explain two, even incompletely, illustrates the condensation we have had to employ in presenting our paper and the impossibility of doing justice here to the numerous questions submitted in the course of the subsequent discussion.

In particular we regret that we must postpone consideration of most of the interesting and important issues raised by the Director General of the Ordnance Survey, Brigadier MacLeod. Fortunately those issues may be reasonably regarded as relating to the technical side of the problem which we hope to review separately later. We will then seek to give these points the attention they deserve. But we feel that his inquiry relating to the fuller definition of the functions of cadastral survey asks for an immediate answer. We have no hesitation in saying that the principal function of any effectively conducted and used cadastral survey is to individualise the units of land parcellation of the territory concerned, not merely pictorially as dummies depicted in miniature on a paper plan, but by means which enable them to be identified reliably and with appropriate accuracy on the ground itself to the satisfaction, if necessary, of a court of law. The accuracy that is appropriate to any particular territory depends on local conditions, among which the most obvious are the value of the land and the character of the parcellation. Thus, to adopt the examples cited in our paper, it is obviously proper and economically justifiable to define the limits of parcels of good cotton-growing land in Egypt with much greater exactness than those of holdings of semi-arid land in Tunis. Greater exactness is again required and justified in the determination of the widths, than of the lengths, of long and narrow strip holdings of fertile land.

But the actual, as distinct from the potentially proper, use made of appropriate cadastral survey in any territory necessarily

depends on the relevant law and on the current practice of the authority administering the land records intended to be served. It is, however, evidently wasteful to employ the resources of a costly and exact machine, such as the Ordnance Survey of Great Britain, to execute such a survey if all that is required is an approximate diagrammatic representation of the parcellation of the land ; while *ad hoc* litigation is really relied upon in the event of dispute as the instrument for authoritative definition of the land to which title has been admitted and guaranteed by the State. But it is to be observed that the pamphlet issued by H.H. Land Registry explaining the system of State guaranteed title to land in England appears to attach much greater authority to the technical operations of the Ordnance Survey than suggested ; for among the essential features of the system is cited the provision of a plan of scientific accuracy . . . identifying the land.

In his expression of his experience of the value of cadastral work Colonel Boulnois emphasised the confusions in the methods of parcel reference numbering that he had encountered. We welcome his testimony on this point, but assure him that the examples cited by him were relatively mild, compared with the combinations of letters, suffixes, indexes, fractionalisations, apostrophes, &c., supplemented by liberal use of the term "bis," which are in use in some countries. But his suggestion that the system of rectangular co-ordination known as the national grid provides the ideal basis for reference numbering cadastral parcels affords another illustration of the difficulty of presenting our subject intelligibly in condensed form. We evidently did not make it sufficiently clear that the simple serial reference numbering of land parcels within a cadastral block that we recommend constitutes also the serial reference numbers of the corresponding folios or pages in the land register, thereby establishing an extraordinarily simple and readily operated self-indexing link between the two. Thus page 1 in the relevant section of the land book carries the record of the title and other information relating to parcel 1 in the block, page 2 those relating to parcel 2, &c. We have already emphasised that whole numbers only and invariably are used. However convenient the location of points on a map by rectangular co-ordination may be, and we have not dealt with maps all our lives without appreciating this, it would be a hardy man who would suggest that they provide a convenient method of numbering the pages in a book. If the method of reference numbering is used that we advocated (and which we learnt from the Swiss) the (elastic) land book is always automatically indexed to correspond, and no other connecting link is needed between the relevant page in the land book and the parcel on the ground to which that page

relates. If rectangular co-ordinates were used as a means of reference numbering, a special and otherwise superfluous intermediary index would be required to indicate what page of the land book related (to adopt Colonel Boulnois's example) to the parcel located on the map by the co-ordinates 123 and 456 of some point within it. But there are also other serious objections to the proposal in connection with cadastral work which we need hardly pursue ; but we none the less welcome the ventilation of this idea. We should perhaps also add that none of these objections apply to the utilisation of the grid simply to identify parcels of land on a static topographical large scale map.

PAPER NO. 590.

AIR-RAID PRECAUTIONS.

By T. E. Scott, F.R.I.B.A.

*Paper to be discussed at the Ordinary General Meeting of
the Chartered Surveyors' Institution on Monday, 3rd
April, 1939.*

It was with some misgiving that I accepted your Council's invitation to deliver a paper on A.R.P., with special reference to the duties of surveyors. The subject is a comparatively new one, and for many the technical issues are still obscured by moral indignation and religious and political convictions.

Before the crisis in September of last year few were able or willing to examine the problem in its technical aspects, and even now, when the need for serious study has been so amply demonstrated, there are many important aspects which have either been ignored or have only been considered superficially. It is therefore difficult, if not impossible, to define in a precise manner the extent to which surveyors may become responsible for carrying out any programme which may be ultimately determined by the Government, but a statement on some of the problems of A.R.P. as they have appeared to me may enable you to decide the duties you will be expected to undertake in solving this great national problem.

The history of A.R.P. commences with the use of military aircraft. Before the Great War, 1914-1918, warfare was confined to the points of contact between opposing armies and the range of artillery; the killing of civilians and the destruction of property could result only from the actual occupation of enemy territory. It was, however, soon demonstrated that the aeroplane and the airship could increase the range of attack and achieve military success by

the destruction of ports, dockyards and munition factories. The deliberate bombing of civilians, although often denied, was inevitable in a war which would so obviously be won as much by the industry and moral resistance of civilians as by armed force. It is probable that, although many casualties were caused, the air raids on London and elsewhere failed to achieve any military purpose for which they were intended; the Air Defence forces were quickly organised, and enemy attacks on important military targets were far from successful. But bombs which failed to find their target had to burst somewhere, and it was evident that any residential town or district might deliberately or otherwise be subjected to aerial bombardment.

I do not propose to advance any views on the bombing of civilians as a justifiable act of war. Recent events in China and Spain have indicated that modern warfare may be waged without distinction between combatant and civilian, and that the battleground is limited only by the range of modern aircraft. All sane people must deplore the problem which the abuse of science has created, but it is a problem which will remain as long as war is resorted to as a means of settling international disputes.

It is not necessary for me to speculate upon the effectiveness of the Air Force and the anti-aircraft services as the first line of defence except to state that I believe active defence and attack to be the best form of A.R.P.; nor need I attempt to explain the many activities of the Air-Raid Precautions Department, such as First Aid, Decontamination, Auxiliary Fire and other services. These services are primarily intended to afford relief after a raid has taken place, and, if properly supported by the population, may be regarded as adequate.

But the most difficult problem of all would appear to be that of providing protection for the civilian population and the various essential public services against the attack of such enemy aircraft as evade the first line of defence.

One thing appears certain—that as far as possible such measures as may be considered necessary and practicable

must be undertaken as peace-time precautions and not merely envisaged as emergency measures to be carried out if and when the need should arise. Even with the whole of the nation's resources of labour and material available for passive defence, it would be impossible to achieve more than insignificant results in the time available between a threat of war and the opening of hostilities.

I do not suggest that the principles which underlie our respective contributions to civilised existence should be abandoned because of a war which none of us wants, but that we should effect a sane compromise between progress towards the ideals which all honest men seek, and the possibility of war which none but fools will dare to ignore.

The possibility of air attack at once introduces a new factor into the planning of progressive civilisation, and it may be an advantage at this point to set forth some few particulars about bombs and their effects.

An air attack may be carried out with three main types of bomb—incendiary, gas and high-explosive.

Incendiary bombs, although a potential source of considerable danger to property, to the nation's stores and to the various public services, are probably less serious in themselves as a menace to human life. Most modern buildings of steel and concrete construction would probably be safe against the incendiary effects of these bombs, but buildings of a domestic type, particularly in densely built-up areas, might suffer considerable damage unless adequate fire-fighting services were available. In this connection it is important to bear in mind the need for prompt action, and any scheme which does not provide for the widest possible distribution of Auxiliary Fire Service personnel may be found to be fundamentally unsound.

For all ordinary building purposes the normal practice of fire-resisting construction should suffice, but special precautions will have to be undertaken in the case of stores of highly inflammable goods and in districts like the London Docks. I shall refer later to the study of this problem in relation to town planning.

The gas bomb is certainly a more fearsome weapon, but used alone I do not think it would constitute a really serious danger except to individuals actually incapacitated by the bursting bomb. It is my personal opinion that a large-scale gas attack is unlikely, but in any case, if gas bombs were used as the only form of attack, almost complete immunity would be secured by those occupying a gas-proof room, with the gas mask as the second line of defence.

But there can be no certainty that incendiary and gas bombs will be used independently, and we are compelled to assume that an intelligent enemy would resort mainly to high-explosive bombs. These would not only have the effect of hampering the work of rescue parties, but might also be the means of damaging or destroying such gas-excluding devices as could be adopted in ordinary existing buildings.

It is evident that chief consideration must be given to protection against high-explosive bombs, and herein lies the most difficult problem of A.R.P.

High-explosive bombs may vary from 25 lbs. to 3,000 lbs. in weight. The size most likely to be used against buildings is the 500-lb. bomb. Bombs may be dropped from aircraft flying at heights up to 20,000 feet or even higher, and the angle at which a bomb arrives will naturally vary according to the height and speed of aircraft from which it is dropped. There is a certain amount of doubt about the penetrative power of high-explosive bombs. It has been stated that certain types of 500-lb. bomb would penetrate 5 feet of reinforced concrete and that a further 10 feet may be necessary to afford complete protection against the resultant explosion.

The indirect or secondary effects of high-explosive bombs are those of fragmentation and blast pressure. The fragments or splinters from a bursting bomb fly in all directions at great velocity. Tests carried out by a Government Research Department indicate that against splinters from a 500-lb. high-explosive bomb exploded at a distance of 50 feet complete protection is afforded by—

Mild steel plate	...	...	...	1½ ins. thick
Stock bricks in cement mortar	...	...	...	13½ „ „
Reinforced concrete	...	...	...	12 „ „
Sand or earth revetments	...	...	...	30 „ „
Shingle between wood sheeting	...	...	...	24 „ „

The blast of air pressure generated by a high-explosive bomb is of considerable magnitude, but of very short duration ; this pressure is followed by a suction wave, which sometimes appears to be more destructive than the initial blast. There is still some uncertainty about the exact effect of blast upon buildings, but there is reason to believe that, except in extreme cases, well-constructed buildings will not suffer more than superficial damage from bombs bursting externally.

One of the most serious consequences of the bombardment of buildings is that of demolition. Reports from Spain indicate that a very considerable proportion of casualties have been caused by the collapse of the upper parts of buildings upon people sheltering in basements—that is to say, in basements the floors over which are not sufficiently strong to withstand the additional load. In this connection, however, it is important to appreciate that most Spanish constructional work is vastly inferior to that usually found in this country.

Consideration must also be given to the dangers resulting from air defence, viz., fragments of anti-aircraft shells and machine-gun bullets, both of which might cause considerable casualties in crowded streets, but against which more or less elementary precautions would be sufficient to provide complete safety.

These are the direct effects of air attack, which must be considered in the study of problems of A.R.P.

WHAT ARE THE PROBLEMS OF A.R.P.?

Briefly they are the prevention of casualties, the protection of those services and supplies which are essential to human existence, and the minimising of damage to property

and materials ; all of these may the more effectively be achieved by due consideration of yet another problem which so many overlook, viz., the maintenance of those industries and services which are essential to bringing a war to an early and successful conclusion.

Many spectacular A.R.P. schemes have been devised which, at first sight, have the appearance of providing a solution to the problem of protecting the population ; but on examination it is often to be found that they are based entirely on the assumption that on the outbreak of a war the civilian population would be free to take shelter, remaining there for as long as might be necessary. Many such proposals neglect entirely the fact that it would still be necessary to maintain the many services which are essential to the very existence of the community.

It is my considered opinion that no aspect of A.R.P. can be studied separately, but that it must be considered in relation to all of the needs of the nation and related as far as possible to peace-time organisation, so that in the event of an emergency disorganisation would be reduced to an absolute minimum.

Many of the requirements of A.R.P. have little in common with the needs of peace. By careful planning it may be possible to effect a satisfactory compromise between the respective needs of peace and of war, but the work involved could be carried out only over a very long period.

It therefore appears necessary to envisage A.R.P. as requiring two policies. The first—an immediate or short-term policy—will be to provide as quickly as possible such temporary measures as may be found practicable. These will of necessity be restricted mainly to the provision of shelter accommodation for such of the population of danger areas as are not scheduled for evacuation. The measures usually include trenches in gardens and open spaces, sectional steel or concrete shelters in gardens, strengthened basements in existing buildings, or underground tunnels or shelters planned on a collective basis. With few exceptions these shelters will serve no useful peace-time purpose and in

many cases will involve a considerable expenditure in maintenance.

The task would be one of enormous magnitude and would, first of all, involve a thorough survey of the areas concerned and of the buildings which have basements suitable for strengthening. The duty of making such surveys is laid upon local authorities, but it could only be carried out efficiently and promptly by enlisting the properly organised assistance of the appropriate professional bodies throughout the country. Similarly, the task of carrying out the structural work in an economical and speedy manner must depend for its success upon the willing co-operation of designers, public works contractors and the various industries concerned.

The second or long-term policy is one which will involve the incorporation of the principles of A.R.P. in the planning of all future undertakings—public and private—which might, in the event of war, become involved in enemy air attack, and, if destroyed, endanger the life, efficiency, health and morale of the nation.

Many aspects of town planning may call for modification ; for example, residential areas must be located as far as is reasonably possible from industrial buildings which may be regarded as military targets, and the various public services, such as power and water supplies and food stores, will have to be suitably located and duplicated so as to reduce the risk of complete dislocation in the event of one source of supply being destroyed. Structural precautions will have to be introduced—possibly in the form of building regulations—to provide protection for the occupants, to reduce as far as possible the risk of damage to buildings by high-explosive bombs, and to protect their contents against the spread of fires caused by incendiary bombs.

The shelter problem remains the largest and the most difficult. Fortunately one serious problem which is created by densely populated areas will in the course of time disappear if, in the vast rehousing schemes now contemplated, due consideration is given to the air-raid menace.

THE NEED FOR A NATIONAL STANDARD.

The study of A.R.P. in relation to the provision of shelters at once discloses an issue which is fundamental, viz., the standard of protection to be provided. It is the point at which scientific investigation must take account of economics, psychology and even common-sense in determining the policy to be adopted. Some students—technical and political—incline to the view that ways and means *must* be devised of affording absolute protection for those who are able to occupy large communal shelters during an air raid ; others are of the opinion that although the standard of protection may have to be limited by what is regarded as a reasonable expenditure on passive defence, such protection ought to be provided in all places of residence and work.

The advantages of complete immunity within a presumably bomb-proof shelter must be set against the inevitable discomfort and possible danger of panic among a closely confined crowd of several thousands of excited people. The certainty of a limited degree of safety which is immediately accessible for all must be compared with the uncertainty and anxiety about reaching a safer shelter through crowded streets before a raid commences.

Decision on these and other aspects of the problem must be reached, and it is a decision which can only be made by the Government. There must be a clearly defined standard for all to follow, for nothing but disastrous chaos could result from the adoption of a different standard by each local authority in London and other large towns.

An indication of the probable official view is provided by the White Paper referred to later, but considerable uncertainty is inevitable while deep shelter proposals are "viewed with interest" by the highest authorities. It is not unreasonable to expect that if a national policy is defined it may take the form of legislation to enforce the observance of building by-laws or a "code of practice" which will ensure the provision of shelter accommodation in all new buildings of a residential character ; such legis-

lation would incidentally indicate the standard of protection which ought to be regarded as a minimum in the alteration of existing buildings, and could with advantage be extended to apply to all other types of buildings which must be occupied during a state of emergency.

EVACUATION.

One of the most important A.R.P. measures is the evacuation from large towns and danger areas of children, invalids and other persons "non-essential to a war economy." Not the least serious result of a war might be the harmful effect on children who experience but survive air raids, and it is therefore well to know that evacuation is engaging the serious attention of the Government.

Some idea of the magnitude of the problem became apparent during the crisis of 1938, when but a few days were available to arrange for sending the children of London and other large towns to safer parts of the country. It is not possible to state the number of children and other persons for whom provision ought to be made, but it may well exceed 5 millions.

Whatever help might be forthcoming from those resident in safer areas, it is obviously impossible to expect that such a vast number could be provided for by means of billeting: overcrowding, the temporary dislocation of food supplies, the inadequacy of sanitation and other public services, and lack of the careful attention which young children need might cause unthought-of dangers to the health and morale of the nation.

Properly organised, and based on a careful and comprehensive survey of water supplies, sanitation and other essential services, and of the accommodation offered or scheduled for requisition, billeting may well provide for a large proportion of the evacuated population, but much additional accommodation would be required.

This is the object of a Government scheme for the provision of a number of national camps. These, it is pro-

posed, will be built and administered by a corporation financed by the Treasury. The camps are to be planned for use in peace-time as camp-schools or holiday camps, being rented by education authorities and approved organisations respectively: each camp will provide for about 350 persons when in normal use, but if used as evacuation camps may accommodate as many as 1,000 persons.

The first programme to be undertaken is stated to consist of the erection of 50 camps: many more will be required to provide for a complete scheme of evacuation.

Here is an opportunity for planning in its widest sense: a measure of A.R.P. which, more directly than any other, will depend for its ultimate success upon the judgment and skill which surveyors and other professional men are permitted to exercise in its execution.

Sites must be selected which are well removed from danger zones, but which can be reached reasonably quickly, whether used as evacuation camps or schools.

They must be near enough to main roads or railways to facilitate the transport of supplies, and although so located as to ensure the "country" atmosphere for recreational purposes, should be near enough to a small town or village to make use of its shopping, postal and other facilities.

Although in the first instance camps may be erected in single units, consideration will have to be given to the possibility of future additions or the grouping of two or more camps sufficiently close together to permit the common use of transport, medical and other services.

The availability of an adequate and economic water supply will be a first essential, together with facilities for sewage disposal. The land must be suitably contoured to permit economical building and the drainage of surface water.

These are but few of the requirements of camp sites, to which must be added the limitations of choice imposed by covenants, town planning requirements, and the undesirability of using valuable farming land.

In the planning and grouping of the buildings, special

consideration will obviously be given to efficiency and economy, both in first cost and maintenance. Standardisation may be an advantage if limited to methods of construction and the planning of units such as classrooms and dormitories, but the grouping of the buildings and their external treatment should be arranged to suit the site and to preserve the natural amenities of the surrounding country.

The study of war-time evacuation at once introduces the problem of hospitals. The ideals of hospital planning are such that the occupants of large modern hospitals could not be made reasonably safe against even the more distant effects of aerial attack. It is probable that in the event of a war the patients in all hospitals in vulnerable towns would be evacuated to temporary accommodation in the country: that such a transfer would be injurious—or even fatal to many—cannot be denied. Many of the reasons for establishing large hospitals in the centres of towns no longer exist: out-patients clinics and casualty stations could remain at strategic centres in large cities, connected by ambulance services to the hospitals situated a convenient distance away. The study of the planning of certain recently completed and proposed hospitals for London will reveal the many difficulties and deficiencies which result from building on too small a site: two such hospitals I have in mind are located in a district which would certainly become the object of heavy attack in the event of war. It is more than a pity that these hospitals were not rebuilt on larger sites in outlying suburbs, where their planning might have more closely approached the ideal from a curative point of view, and where they would probably be usable in time of war when the demand for surgical attention is likely to be the greatest.

TRENCHES.

With a few rather notable exceptions the trench cannot be regarded as other than an elementary emergency measure. Not that the trench does not provide a very good

degree of protection, for, if properly located and provided with overhead cover against falling fragments of bomb or shell case, it will afford protection against all the effects of high-explosive bombs except a direct or very near hit. But I cannot regard the trench as a suitable place of refuge for women and perhaps children, particularly in winter, when illness through exposure might be more serious than the effects of enemy action. As a temporary measure trenches may be necessary, but if provided in any area where more substantial or permanent shelters were available for a proportion of the population it is doubtful whether they would be used. The maintenance of trenches is very costly, and open to very strong and obvious objections where they take up valuable space in public parks.

One of the few instances where the trench may be constructed as a permanent form of shelter is in the case of large works having adequate open space closely available. I have in mind a scheme provided for about 15,000 people who work mainly in single-storied engineering sheds. They are to be accommodated in widely spaced trenches which all could reach in less than two minutes. The trenches have overhead protection against falling splinters and small incendiary and gas bombs, and afford complete lateral protection against h.e. bombs bursting a few yards away.

Instructions on the lay-out and strutting of trenches is contained in various Home Office publications.

SHELTERS.

Much has been said and written about shelters. The popular and technical press have given publicity to countless official, professional and trade proposals which cover the whole range of shelters in principle, design and detail. Attempts have been made to calculate the degree of probability of a direct hit on a shelter and its vulnerable area, and to assess the proportion of casualties among persons who occupy various types of shelters: unfortunately these interesting theories do not indicate what is likely to happen

to those who are prevented from occupying a shelter through an insufficient period of warning or some other contingency. In short, there is so much technical data available upon which to exercise one's power of judgment that any descriptive matter here would be superfluous. I shall, therefore, content myself with drawing attention to two documents: the report* by the engineers appointed by the Lord Privy Seal to consider certain aspects of air-raid shelters, and a report by a firm of architects and an engineer to the Finsbury Borough Council.

The first of these deals mainly with sectional steel shelters and strengthened basements, implying a preference for widely distributed shelters "in close proximity to the home of every citizen in vulnerable areas. Such shelters should provide reasonable protection against blast and splinters from a medium-sized h.e. bomb and against the collapse of the superstructure." The report also refers to the more costly but more efficient and permanent form of "pill box" shelter constructed of concrete which could be erected in groups at the intersection of garden fences to provide for 2 or 4 households.

The second report recommends the construction of a number of large underground shelters of two types to accommodate 7,000 and 15,000 persons respectively, so situated in the borough as to be available to the whole population in 3 or 4 minutes. The authors of this report propose that they should be made "bomb-proof" and provided with gas-filtration units: the probable cost is given at about £10 a head, a figure which many consider to be extremely optimistic.

Those who advocate this form of "collective" shelter frequently claim that it is the only satisfactory solution in overcrowded areas. It would be interesting to know what proportion of the population could be rehoused by spending the money required for shelters on new dwellings elsewhere, thus removing to some extent the excuse for collective shelters.

* Cmd. 5938, H.M. Stationery Office.

Both of these reports are prepared by technicians whose technical knowledge commands respect, but by their wide variance suggest that structural precautions against air attack will ultimately have to be determined by a national standard or policy.

STRUCTURAL PRECAUTIONS IN NEW BUILDINGS.

About three years ago the Government set up a Committee to study the problem of structural precautions against air attack: all available data was placed before the Committee, whose recommendations were related to a standard of protection which it was thought would be found economical and practicable in building design and construction.

The substance of the conclusions of the Committee was incorporated in a paper read at the Royal Institute of British Architects, and is adopted here in the belief that it may not vary considerably from the requirements of future legislation.

Structural precautions in new buildings should be designed to—

- (a) resist the penetration of incendiary bombs of 1 kilo in weight ;
- (b) prevent or minimise the spread of fires caused by incendiary bombs ;
- (c) prevent more than superficial damage to buildings by h.e. bombs of 500 lbs. in weight bursting not nearer than 50 feet from the building, and minimise the damage caused by similar bombs bursting closer than 50 feet ;
- (d) minimise the damage caused by the demolition of the upper part of the building ;
- (e) afford protection to persons accommodated in shelters within or adjacent to buildings against anti-aircraft splinters, gas, fire, the demolition of the upper part of the building, and the effects of a 500-lb. h.e. bomb bursting not nearer than 50 feet.

It will be observed that no reference is made to protection against direct hits from high-explosive bombs. It is generally considered that high-explosive bombs of about 500 lbs. are most likely to be used in attacks on buildings or built-up areas, and, as already stated, the thickness of concrete required to resist penetration by this kind of bomb is quite impracticable in normal buildings. Even if roof slabs were designed to resist penetration by a smaller bomb (for a 25-lb. h.e. bomb a concrete slab at least 16 inches thick might be necessary) it must be appreciated that the force of impact would probably be sufficient to destroy the supporting girders and stanchions, and the heavy roof slab would collapse upon the lower part of the building. It is impossible to anticipate the exact nature of a bomb which might strike a building ; its angle of arrival and point of impact are equally uncertain, and in closely built-up areas of tall buildings it is probable that a large proportion of bombs would detonate somewhere between the roof and ground level. It therefore appears reasonable to avoid the construction of extremely heavy roof slabs which would rarely resist penetration by h.e. bombs, and which might add considerably to the risk of serious demolition and consequent injury of persons in the lower parts of buildings.

Protection against the 1-kilo incendiary bomb is afforded by a 4-inch slab of reinforced concrete. This is obviously a simple matter in buildings where fire-resisting construction is employed.

In buildings where slate or tile-covered timber roofs are preferred for economic or other reasons, complete protection cannot be provided for the whole building, but the use of a suitable sheet material as an attic floor covering may confine a fire to the roof space. Materials are also available for making roof timbers fireproof.

In buildings having floors and roof of timber it is suggested that the floor over one selected ground storey room should be constructed in reinforced concrete ; this would give protection against small incendiary bombs and

if suitably designed would serve as the "demolition" slab referred to later.

The prevention of the spread of fires will be achieved by the adoption of fire-resisting construction. In the case of new warehouse buildings erected near to existing buildings where the fire risk is exceptional, it may be an advantage to omit windows—frequently introduced without practical reasons—and to rely upon artificial lighting and mechanical ventilation.

The blast effect of bombs depends largely upon the extent to which the explosion is tamped or confined by adjacent buildings: the damage caused in a narrow street may be greater than in a very wide one.

It is, however, reasonable to assume that well-constructed buildings having walls at least $13\frac{1}{2}$ inches thick will be safe against blast pressure from a 500-lb. h.e. bomb bursting 50 feet away.

It is not economically practicable to design sure protection against the most intense blast effects from very large bombs, but the evidence available indicates clearly that a steel or reinforced concrete-framed structure would be less liable to complete or serious collapse than one having solid load-bearing walls.

Research, and evidence from Spain, indicate that features such as balconies, cornices, eaves and other projecting members may be readily dislodged or destroyed by blast, and that porticoes, arcades and similar architectural features would be particularly vulnerable unless constructed with a steel or reinforced concrete framework.

Lightly constructed pitched roofs might also be seriously damaged by blast pressure or by the following section wave, but if well secured to the walls and adequately braced, the damage would in many cases be limited to dislodged tiles or slates.

Windows, doors and rolling shutters of normal construction are likely to be destroyed by blast pressure from considerable distances. Many tests have been carried out on

various protective devices for window openings: the results illustrate the extreme difficulty of the problem, and it is urged that no reliance should be placed on shutters or other protective devices which do not meet with the full approval of the Home Office.

Reference has already been made to the thickness of walls necessary to afford protection against splinters.

It has already been stated that one of the most serious effects of aerial bombardment is the collapse of the upper parts of buildings due to a direct hit or intense blast pressure. Such collapse is less likely in the case of buildings which have considerable lateral strength, a condition usually found in a framed structure. The extent of collapse would usually be less in the case of framed buildings, where external walls, internal partitions and floor slabs are reduced to a minimum thickness and weight consistent with normal requirements, and where wall panels and floor slabs may become detached from the framework without seriously affecting its stability. In domestic and office buildings where there are no exceptional floor loadings, special precautions are not necessary beyond the provision of a demolition slab immediately over all shelter accommodation (this will be referred to later). Where there are heavy architectural features above roof level, and heavy loads such as tanks and lift machinery on the topmost storey, a strong floor or roof slab should be provided to support these loads if dislodged.

Shelter accommodation within buildings will normally be required for those likely to remain in occupation during a state of war, but in special cases provision should be made for a larger number of people. For example, shops and stores should provide for customers or pedestrians in shopping centres who would naturally seek refuge in the only available buildings: in the case of large blocks of flats, the shelters may provide not only for the occupants of the flats, but also for residents in neighbouring houses which are not capable of being adapted to provide reasonable shelter accommodation.

For obvious reasons the number accommodated in each shelter or compartment should be limited: the official limitation is 50 persons, but this may be adjusted to meet the needs of individual buildings so long as the principle of dispersion is observed as much as possible.

The area to be provided for each person has been the subject of considerable investigation in relation to the need for affording protection against poison gas for long periods. Research indicates that persons may remain in hermetically sealed rooms for reasonably long periods if the wall and ceiling surfaces are capable of condensing the moisture of respiration; it was at one time officially recommended that the accommodation of a gas-tight shelter without filtered ventilation should be based on allowance of 75 square feet of "cooling surface" for each person: this allowance has since been slightly reduced. It is obvious, however, that this condition would involve a much greater floor area for each person than is essential for reasonable comfort and freedom of circulation, for which purposes an allowance of 6 square feet per person would be adequate. It is my opinion that large-scale gas attacks are unlikely, and that even if they occurred persons protected against the other effects of air attack could rely upon gas masks to protect them while moving to gas-free areas or to the upper parts of buildings. It is, therefore, a wise policy to concentrate on providing shelters against high-explosive bombs, assuming a comparatively short period of occupancy.

As a general rule shelters are best provided in basements, where a considerable degree of lateral protection against blast and splinters is afforded without special constructional work. It is important to consider the dangers which may result from damaged sewers and water mains, but this is a risk which would have to be incurred where it is impossible to provide reasonable shelter above ground level. In some buildings one or more sub-basements are available, but it may still be preferable to use the first basement in order to simplify the problem of planning

adequate and alternative means of access to the shelter.

The floor immediately above the shelter and over the corridors and staircases which gives access should be designed to carry any additional loading which might be caused by the demolition of the upper part of the building.

In buildings which have machinery or exceptional loads on upper floors, these "demolition" or "débris" floors must be the subject of special calculation, but in buildings used for normal office or residential purposes they should be designed to carry the following loads *in addition* to the normal loading of the floor and its weight.

Buildings of solid load-bearing wall construction.

Two storeys over—200 lbs. per foot super.

Three ,, ,, 300 lbs. per foot super.

Four or more ,, 400 lbs. per foot super.

Framed Buildings.

In all cases —200 lbs. per foot super.

There appears to be a decided psychological preference for sheltering below ground level, but in many buildings equally safe shelters may be provided at or above ground level.

The ground floor and one or more upper floors may be suitable for the location of shelters if walls can be provided of sufficient thickness to afford lateral protection against blast and splinters. For obvious practical reasons this protection could rarely be provided in rooms adjoining external walls, where for peace-time purposes adequate daylight and natural ventilation are essential; but where internal corridors are provided, it would not add greatly to building costs to construct the corridor walls in concrete or brickwork of the required thickness. Borrowed lights—rarely very efficient—could be omitted, and door openings reduced to an absolute minimum so as to limit the vulnerability to splinters which may enter window openings in

the external walls of the buildings. These protected corridors would serve their normal peace-time purpose and would not interfere with the planning of the remainder of the building or the external architectural treatment. They should have strong floors, monolithic or well bonded to the walls, and be connected with at least two staircases contained within similarly strong walls, thus providing a more or less independent structural shelter unit within an otherwise normal building.

In some types of buildings, such as multi-storied factories, it is essential to provide large floor areas free from corridors, having widely spaced stanchions and external walls consisting almost entirely of glass. In such buildings where there is no basement, shelter accommodation may be provided in the form of towers extending the full height of the building, and incorporating the staircases, lifts, landings, lavatories and other minor units of accommodation which may be required for normal purposes. These towers, carefully grouped around the two or more staircases invariably required, should be contained within walls thick enough to afford protection against blast and splinters, and have a roof strong enough to keep out small incendiary bombs. Windows should be omitted or reduced to an absolute minimum and provided with splinter-proof shutters. In the majority of cases such vertical shelters or towers would accommodate the number of persons concerned—if necessary by using the staircases—without adding to the areas required for peace-time purposes, and, as in the case of the previous type of shelter, would not restrict the planning or design of the rest of the building.

These three types of shelter—the basement, the internal corridor, and the staircase tower—are capable of application to the design of most modern buildings.

A notable exception is the small house, in which the external walls are usually of brickwork 9 inches or 11 inches thick, and the floors and roof of timber. It is possible, however, to provide approximately the same degree of protection for the occupants—usually few in number—with-

out inconvenient planning and without excessive additional cost.

The shelter should take the form of a protected room, preferably the kitchen or scullery, where water, food and other necessities are readily available. The external walls of the room should be $13\frac{1}{2}$ inches thick to afford standard protection against blast and splinters, and the internal partition walls should be 9 inches thick. The planning should preferably provide one door only, and the window should have a cill level high enough to protect occupants when sitting down against splinters which enter the window opening. The floor over the protected room should be of reinforced concrete at least 4 inches thick. Such a shelter would provide reasonable protection for a family at reasonable cost: it avoids the discomforts of trenches and sectional steel shelters in gardens, and would not involve the risks attendant upon even short journeys to communal shelters.

STRUCTURAL PRECAUTIONS IN EXISTING BUILDINGS.

It will be obvious that the more closely existing buildings conform to the principles involved in the application of A.R.P. to new buildings, the greater will be their resistance to effects of air attack.

Each individual building will have to be examined in order to determine whether reasonably safe accommodation may be provided and what structural measures should be devised to increase its effectiveness.

In the examination of existing buildings the following points should be given careful consideration:—

- (a) The undesirability of providing protected accommodation in or near to buildings, the occupancy of which involves abnormal fire risks, such as in the manufacture or storage of highly inflammable materials.
- (b) The serious risk of complete demolition in buildings of doubtful lateral stability which are in-

capable of being strengthened permanently or in an emergency.

- (c) The low degree of fire resistance of buildings constructed largely of timber.
- (d) The expenditure and inconvenience involved in providing protection against splinters in buildings which have an exceptionally large proportion of window area in external walls and very thin internal partitions.
- (e) The additional dangers which may result from the demolition of heavy architectural features such as pediments, gables and towers upon a sub-structure of inferior quality.
- (f) The dangers which may result from the displacement of heavy objects such as storage tanks and machinery situated on upper floors, and of flooding in low-lying areas.

In some cases a degree of protection against incendiary bombs may be provided by the use of suitable materials as a lining or floor covering to the roof space.

Lateral protection against splinters and blast may be obtained by the location of shelter accommodation in a basement or by the erection of sufficiently thick walls of a suitable height.

In some cases windows to accommodation scheduled for shelter purposes may be bricked up ; but where this is not possible, suitable sliding or other shutters may be installed for use in emergency.

The area of the shelter must obviously be related to the number of persons to be accommodated. As previously suggested, some consideration may be given to the possible need for long periods of occupancy owing to the risk of gas attack, but as a general rule it will be preferable to provide good protection against the effects of high-explosive bombs even if in so doing the area available does not reach the standard required for air-tight compartments.

It is obviously desirable to select accommodation which

can be readily and permanently prepared for use without serious interference with its normal occupancy. The shelter accommodation must be so located that it will be easily accessible to personnel and have alternative means of escape for use in the event of one of the entrances being blocked up by *débris*.

Where basements exist they will usually provide the best location for shelter accommodation, as protection against blast and splinters is afforded without additional structural work. It will also be appreciated that the walls and floors over may afford some protection by detonating a bomb which strikes the upper part of the building, but protection must be given against falling *débris* in the event of the upper part of the building being damaged.

This should be achieved by the strengthening of the floor over the shelter by means of additional supports which must be strong enough to support *débris* loading in accordance with the figures already given.

Floors of timber construction should be lined on the underside with a suitable fire-resisting boarding and additional strength provided by means of a sufficiently thick planking supported at frequent intervals by means of timber or steel beams. These beams should be in turn supported by stanchions or, where more convenient, by means of brick walls or piers which must be carried down to a solid foundation.

In floors having a brick or concrete arched construction the additional supports should take the form of planking 2 or 3 inches thick supported at suitable intervals by means of shaped bearers: these must be supported by a system of steel or timber beams and pillars.

Floors of concrete construction should similarly be supported by planking 2 or 3 inches thick at about 3-inch intervals, also supported at suitable centres by beams and pillars.

The planking should usually be fixed close to the ceiling but it need not be wedged up tight so as to take the initial impact of falling *débris*. It is probably reasonable to

assume that if the original floor construction yields slightly under the impact load of falling débris it will have absorbed a considerable amount of energy, thus reducing the subsequent impact on the temporary strutting.

The foregoing recommendations indicate a preference for the use of timber planking owing to the greater ease and speed of fixing, but in some cases it may be practicable to thicken an existing concrete floor slab by the insertion of pre-cast concrete units or of mass concrete between the ceiling and a form of steel shuttering or closely spaced steel girders.

Shelters may be formed by the construction within a room or corridor in an existing building of a complete shelter unit similar to those recommended for use externally.

It is to be expected that in the near future legislation may require a considerable amount of work to be done in the way of strutting existing basements, in which case it will be necessary for economic reasons to make use of all suitable forms of construction and materials available for the purpose.

In this connection we may await with interest the official reports on tests now being carried out by the demolition of old buildings upon strengthened basements and lower floors. It is by no means improbable that timber floors will be found to withstand the effects of demolition far better than floors of very light and inferior fire-resisting construction, particularly of the kind used extensively in Spain which appears to have been so easily destroyed by demolition.

Tables giving dimensions of timber and steel strutting are included in recent Home Office publications: these may be adopted in smaller buildings where the structure is obviously sound and the floor loadings normal; but it is strongly recommended that in all other cases the strengthening of basements should only be carried out under the direction of properly qualified persons experienced in constructional work.

Reference to the use of sandbags is confined to a recommendation that they should not be relied upon for erection

in an emergency except where some form of permanent structure is quite impossible. Guidance is to be found in various Home Office publications.

TOWN PLANNING.

The ideals of town planning are for the most part consistent with the principles of A.R.P., the chief of which is dispersion.

The traffic problems of peace time would be accentuated in time of war, particularly during the evacuation period, and the carrying out of road planning schemes has military as well as civil and commercial advantages.

I do not intend to comment on the various proposals for solving traffic problems by means of underground arterial roads except to object to the argument often advanced that they would be useful as air-raid shelters.

One feature of town planning which calls for serious consideration is that relating to the grouping of industrial buildings.

From an A.R.P. point of view it would be an advantage to dispose industries individually over as large an area as possible, but the commercial disadvantages would be insuperable. The location of industry cannot be divorced from transport facilities, both of workers and materials, and, moreover, it would be contrary to established principles of planning to intermingle residential and manufacturing buildings in inharmonious groups. But at the same time it must not be overlooked that the practice of developing trading estates as at Slough and Trafford Park has the effect of creating large and attractive targets for aerial attack, and neighbouring residential areas might become involved without being the primary objectives.

Perhaps the most that can be expected is a stricter observance of a planning principle rarely carried out in practice by providing adequate open spaces between industrial groups and residential areas.

There is also the problem of the location of certain industries which, although not at present affected by legislation, should not be permitted in residential areas. These indus-

tries include those which might constitute an exceptional danger in time of air raids owing to their highly inflammable nature, *e.g.*, paint and varnish works and large timber stores.

These and other problems of a similar nature must of necessity involve solutions of a long term character, but if any action is considered desirable it ought to be taken immediately, when so many far-reaching town planning schemes are only in the planning stage.

CONCLUSION.

This brief survey draws attention to some of the problems in which instinctive self-preservation must compel the interest of every member of the community ; but more than interest is necessary if the problems are to be solved.

It has been my experience that most public authorities and private individuals are willing and anxious to fulfil their responsibilities, but they have for the most part quite rightly refused to be stampeded into undertakings of a fantastic, costly and probably misleading character ; there is a very evident reluctance to accept the recommendations of enthusiastic but obviously incompetent officials.

It cannot be denied that the present state of affairs in Europe demands the immediate carrying out of a tremendous amount of work of a more or less temporary nature ; but however temporary and whatever the degree of urgency, there can be no excuse for ignoring the existence of those professions capable of providing the skill in planning and experience in organisation which are so essential.

It will be a poor commentary on the efficiency and foresight of our generation if our only solution to this urgent problem provides for future generations a legacy of ill-considered and hastily contrived shelters which will be neglected as soon as the threat of war is forgotten.

We cannot afford to ignore our own immediate needs, but what is of perhaps greater importance is that we should so plan and organise our contributions to the amenities and services which future generations will enjoy that they may be spared something of anxiety we now experience.